



The Forecast Impact of Atmospheric Motion Vectors Derived from AIRS Moisture Retrievals

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2014 NASA Sounder Science Team Meeting
Greenbelt, MD

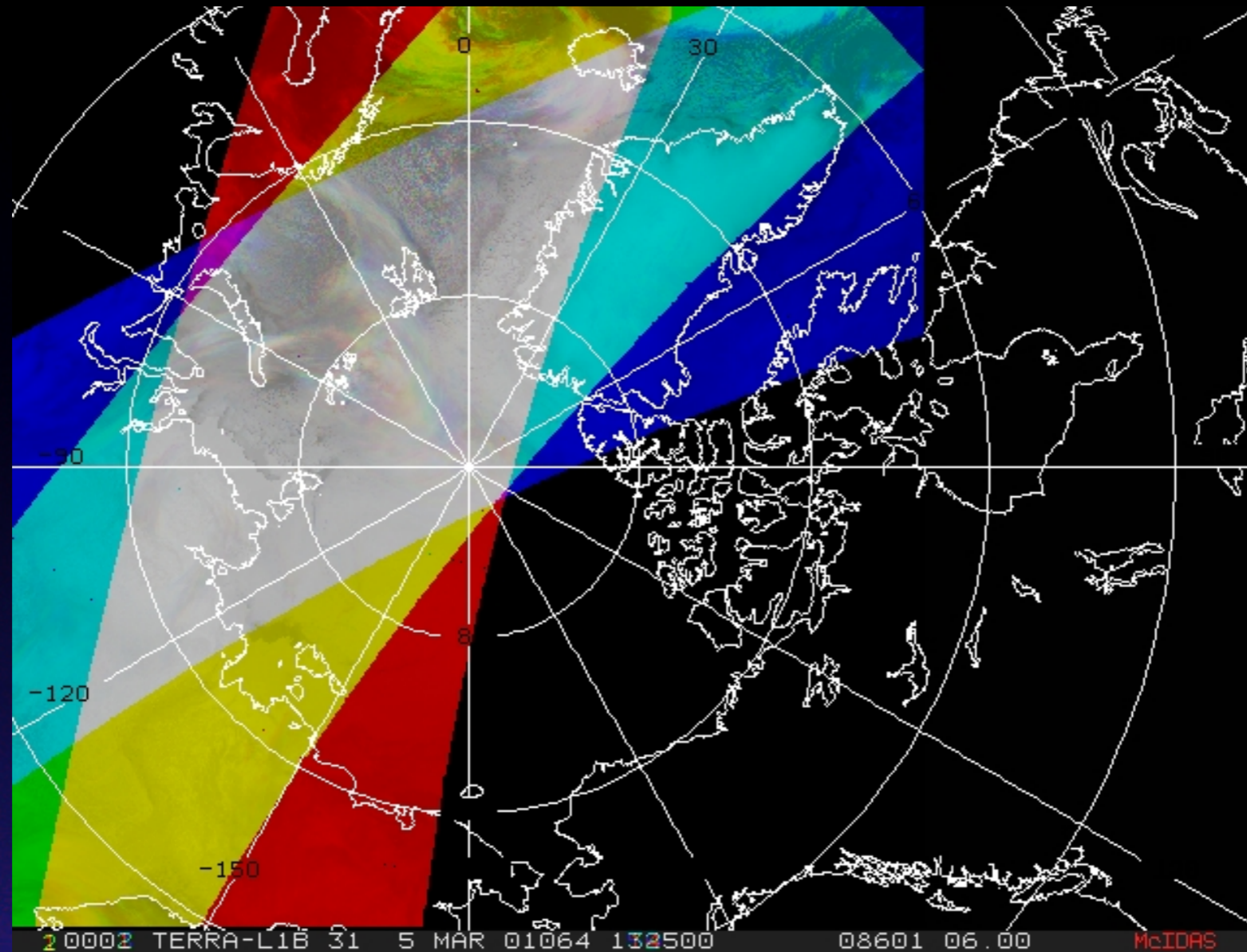
1 October 2014

Outline



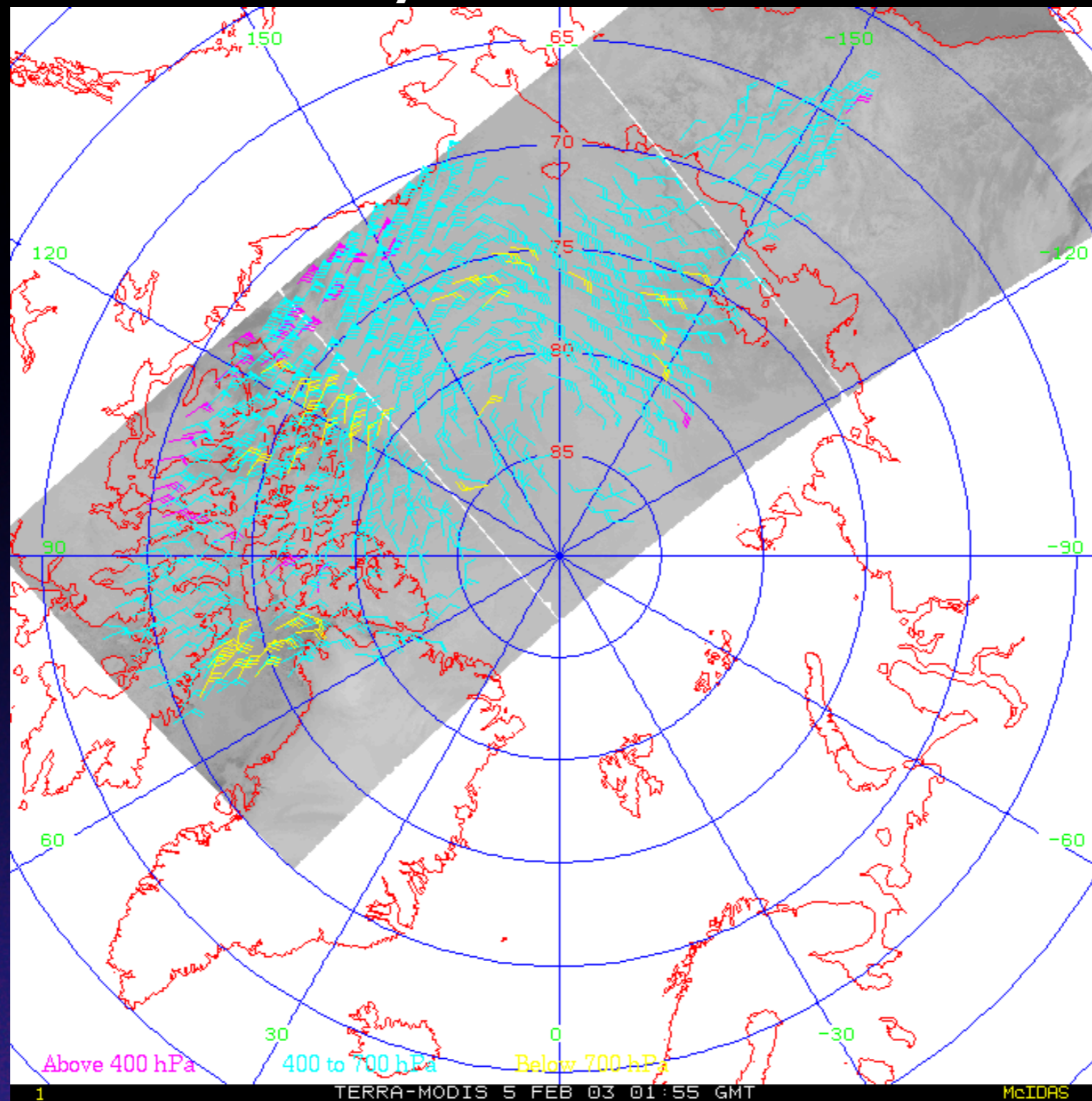
- 1) Overview of MODIS polar winds
- 2) Applying to images of retrieved moisture and ozone
- 3) Assimilation impact
- 4) Forecast impact
- 5) New award
- 6) Future considerations

Satellite-derived Polar Winds



Unlike geostationary satellites at lower latitudes, it is not possible to obtain complete polar coverage at a snapshot in time. Winds must be derived for areas that are covered by three successive orbits. The gray area is the overlap between three orbits.

One Day of Arctic Orbits



MODIS band 31 ($11 \mu\text{m}$)

Tracking humidity features from AIRS retrievals



Project Overview

- Determine to what extent AIRS-derived AMVs can provide useful wind information.
- Advantages:
 - a) 3-dimensional winds dataset
 - b) Implicit AMV height
 - c) Clear sky and above cloud
 - d) No water vapor imager channel after MODIS (polar orbiter)*



AIRS Retrieval

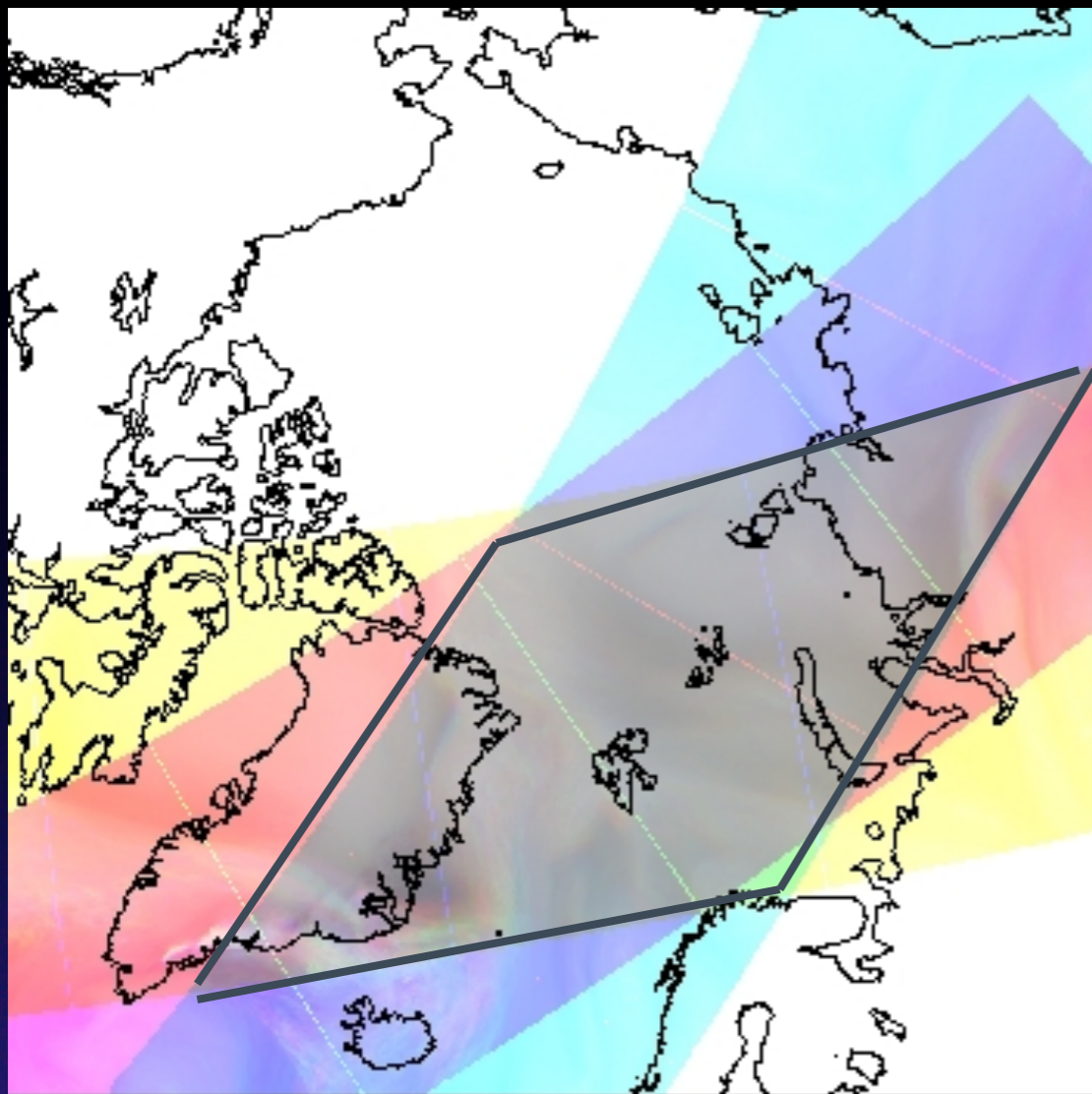
- Use the SSEC SFOV AIRS retrieval algorithm
 - a) Need highest possible spatial resolution
 - b) Retrievals of moisture and ozone mixing ratio at 101 pressure levels:
 - i. Away from tropopause and surface for AMVs
 - ii. Ozone: 103 to 201 hPa
 - iii. Moisture: 359 to 616 hPa
 - c) Elisabeth Weisz and Bill Smith

New Challenge: Lower resolution



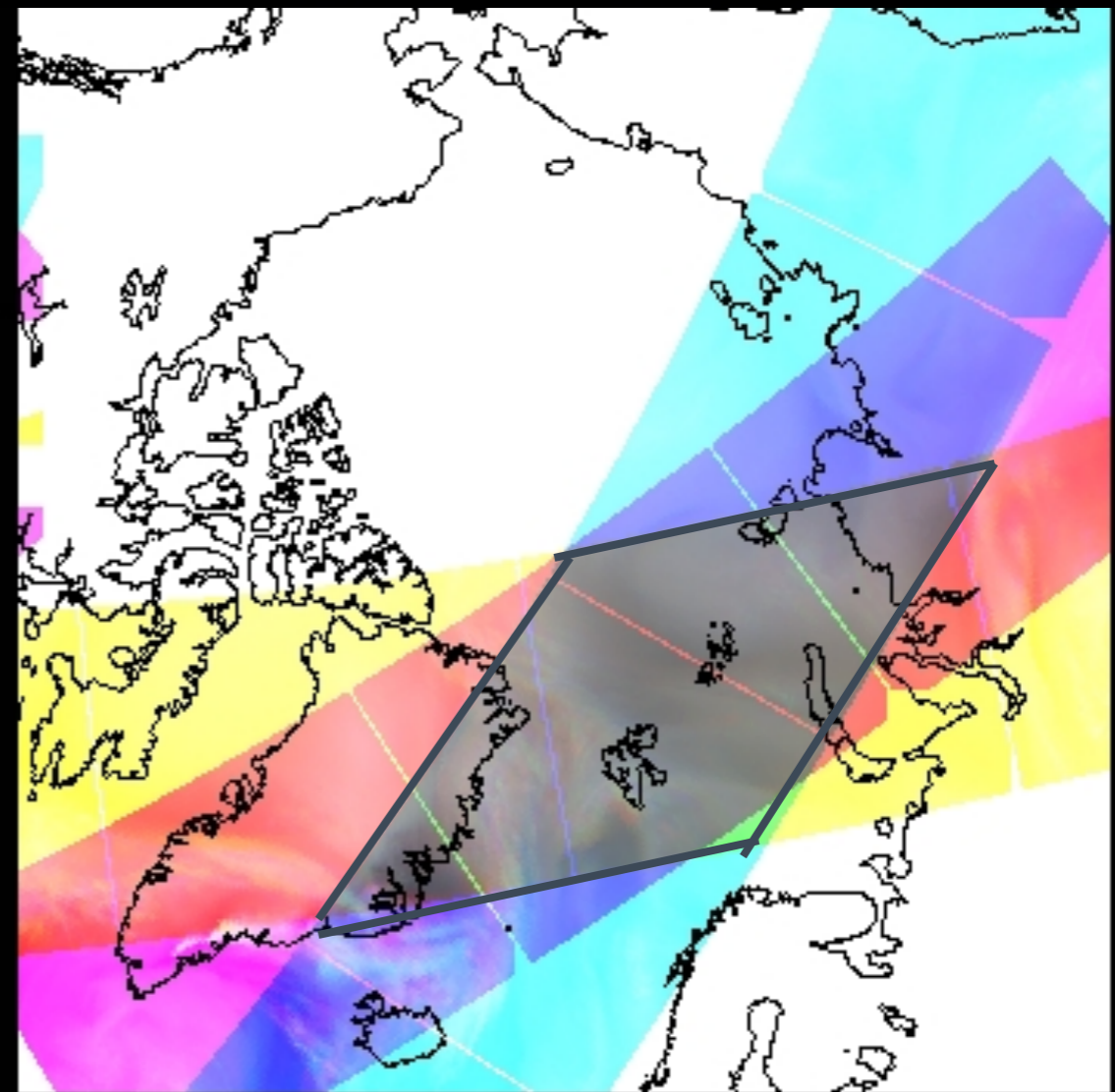
- AIRS: 13.5 km; MODIS: 1 km
- Images at 16 km (AIRS) and 2 km (MODIS)
- Magnify images with bi-linear interpolation
 - a) Increase winds algorithm parameters to match magnification
 - b) Cross correlation for tracking features behaves much better

Polar Winds Coverage MODIS vs. AIRS



AQUA MODIS COVERAGE

MODIS scans $\pm 55^\circ$

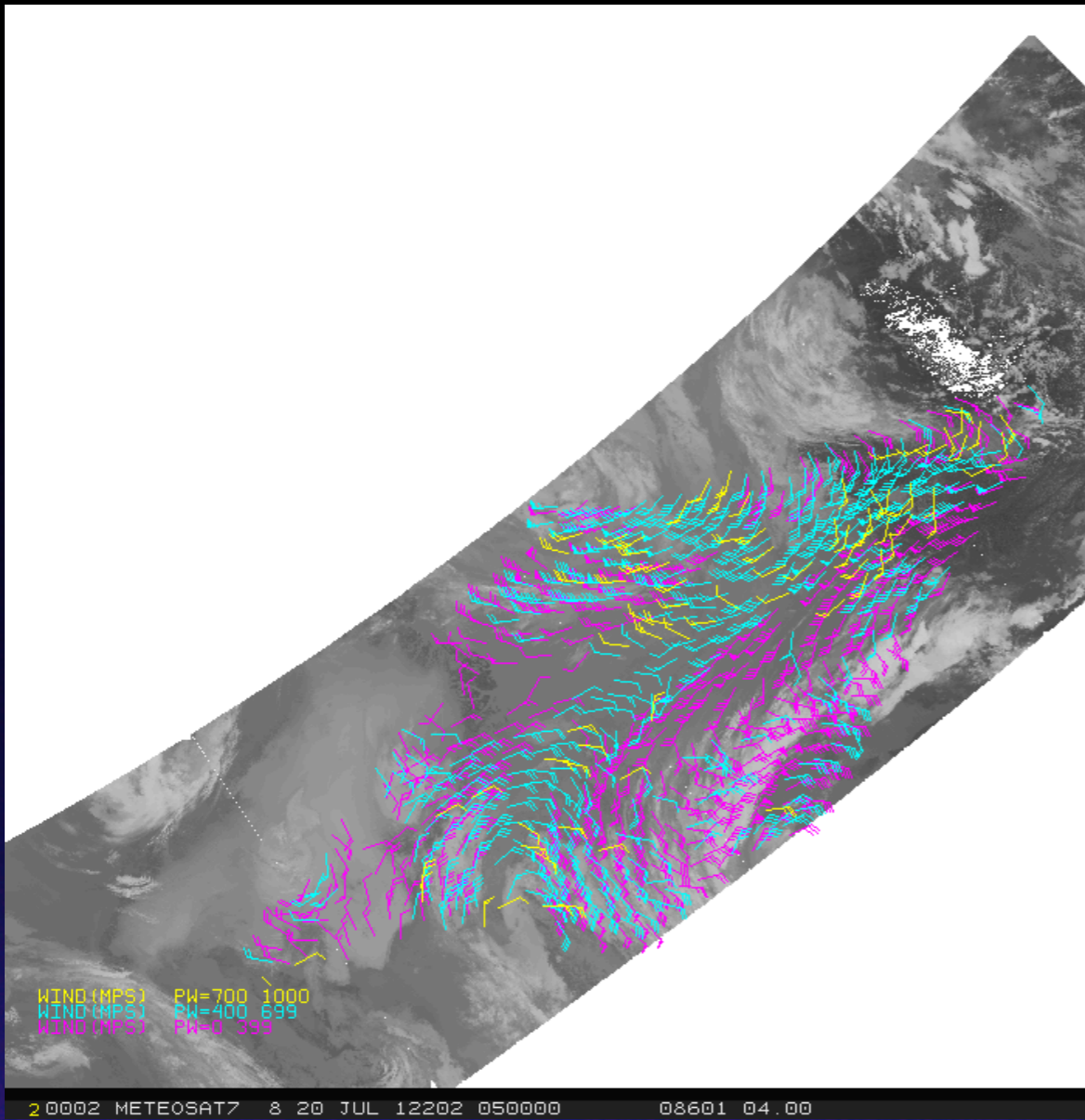


AQUA AIRS COVERAGE

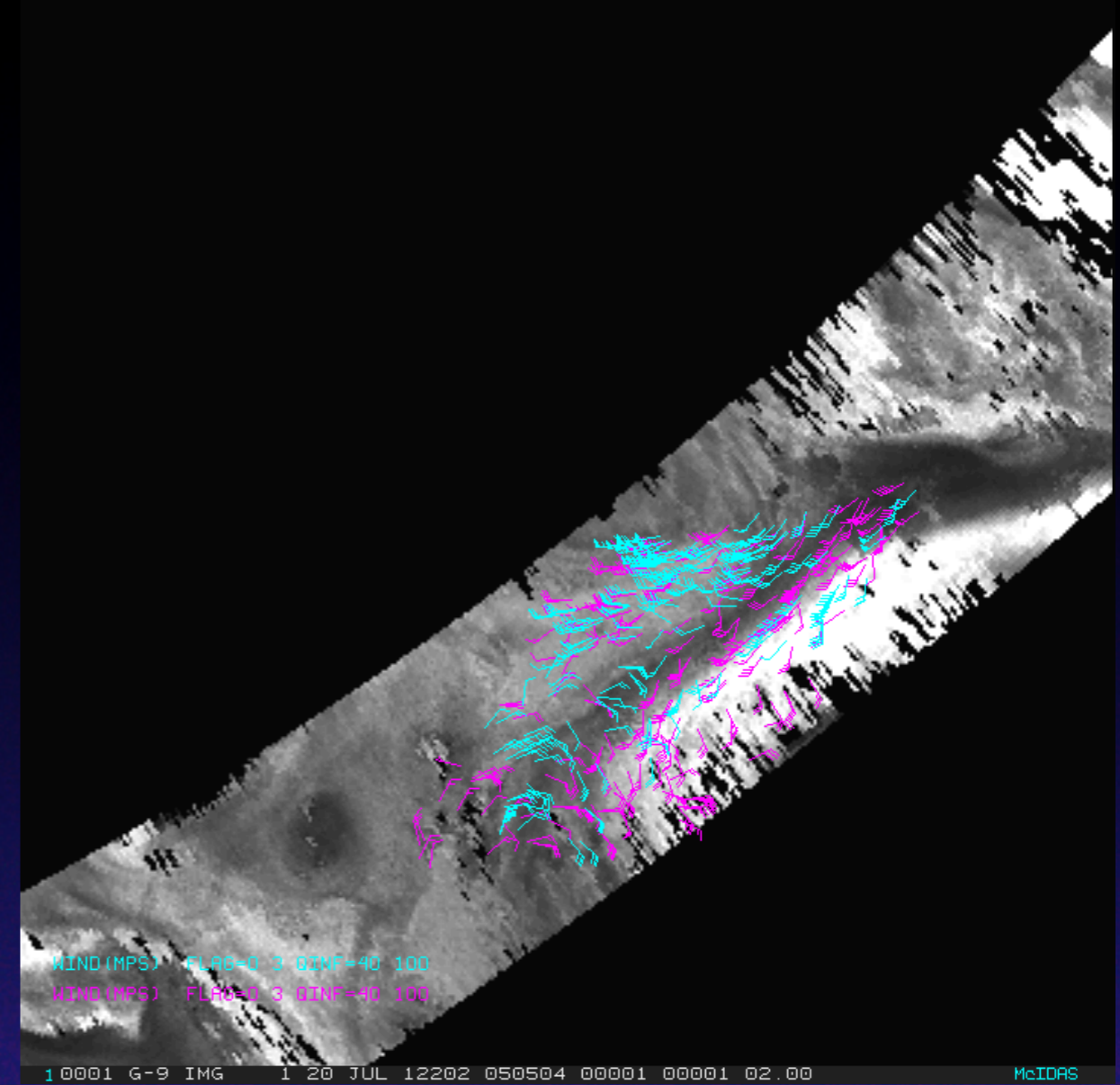
AIRS scans $\pm 49.5^\circ$

Aqua MODIS AMVs

AIRS Retrieval AMVs at All Levels



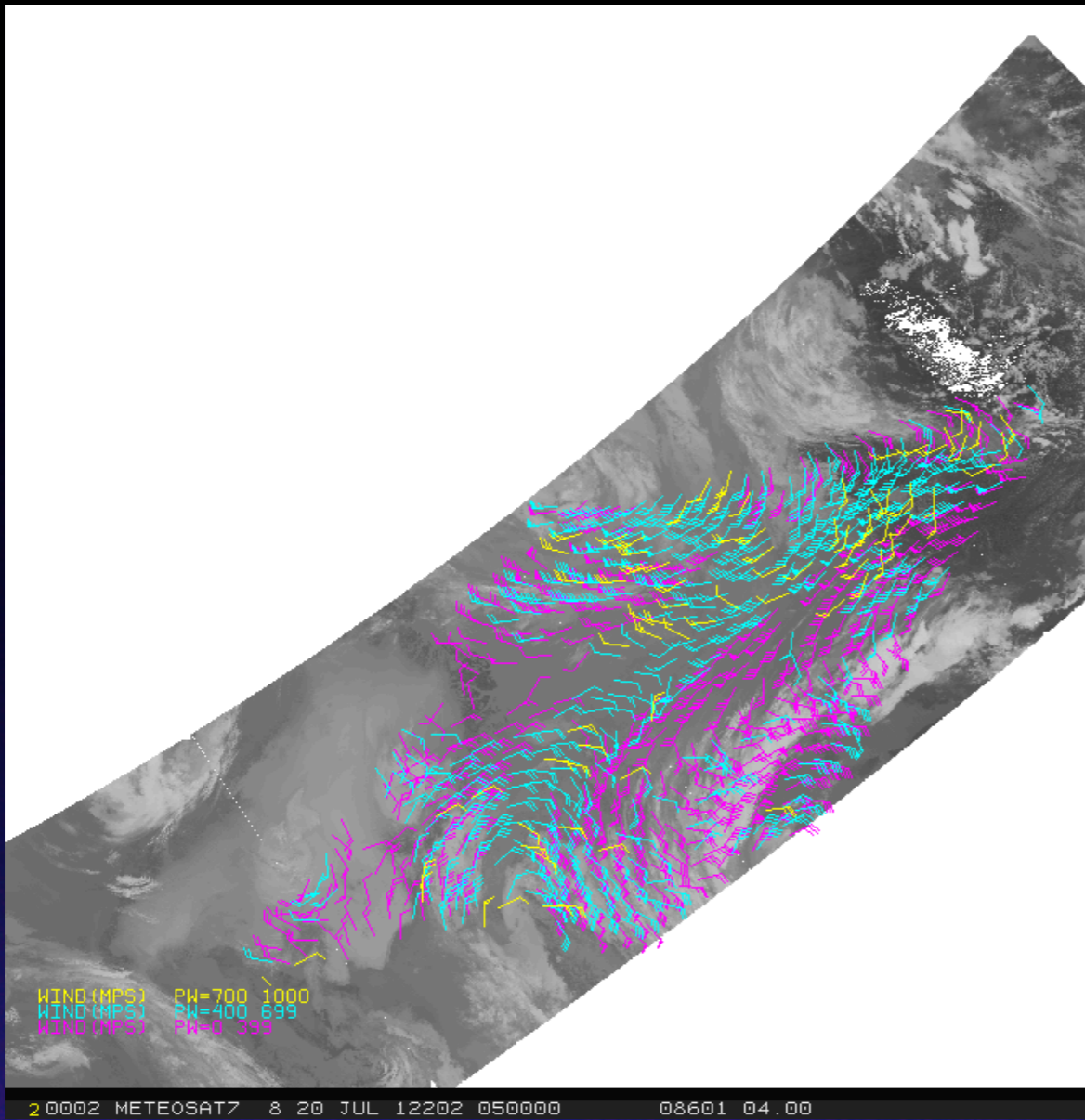
MODIS 20 July 2012 0551 UTC
Infrared and Water Vapor
(including clear sky)



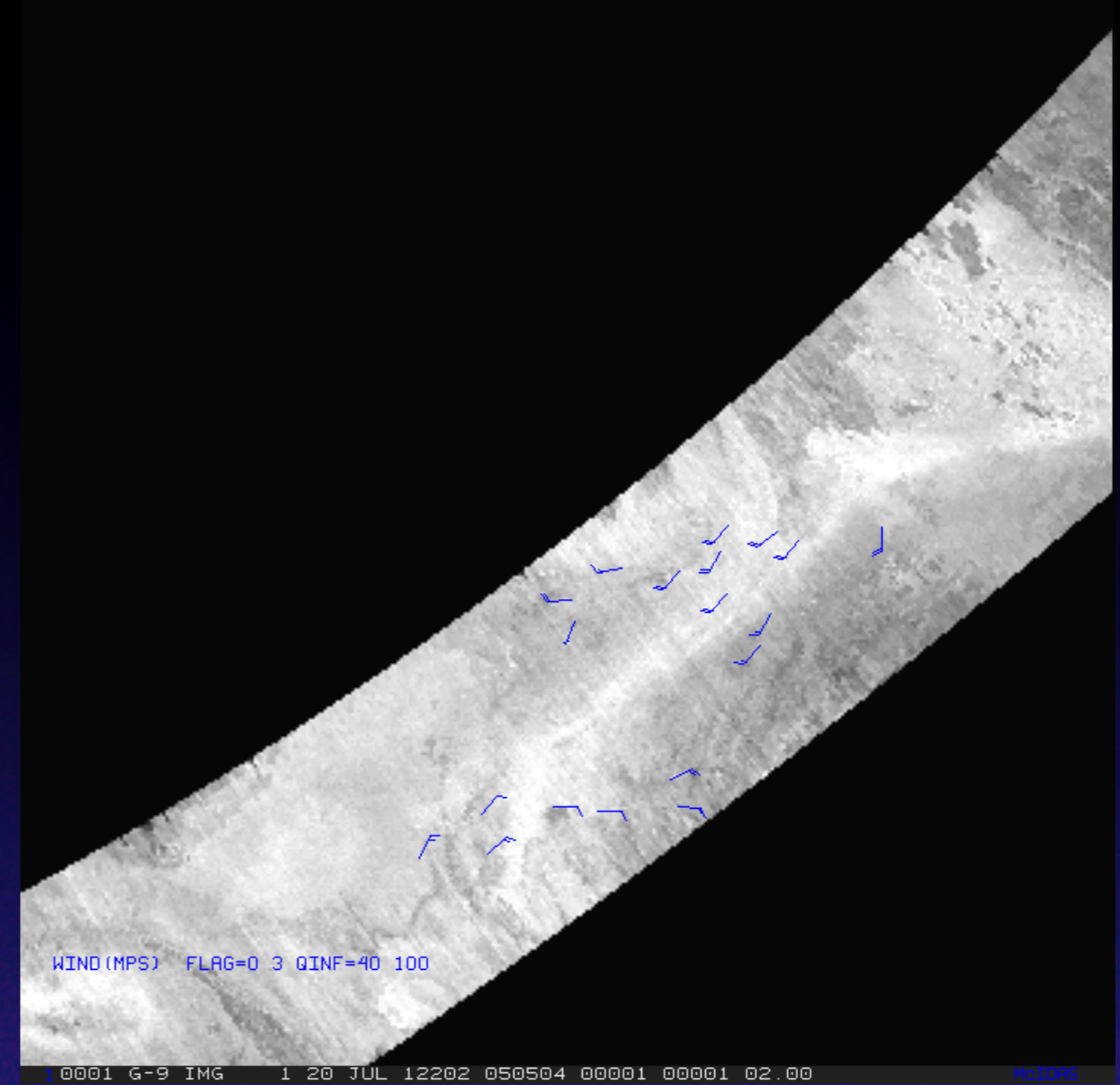
AIRS 20 July 2012 0505 UTC
Ozone: 103 to 201 hPa Moisture:
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Aqua MODIS AMVs

AIRS Retrieval AMVs at All Levels



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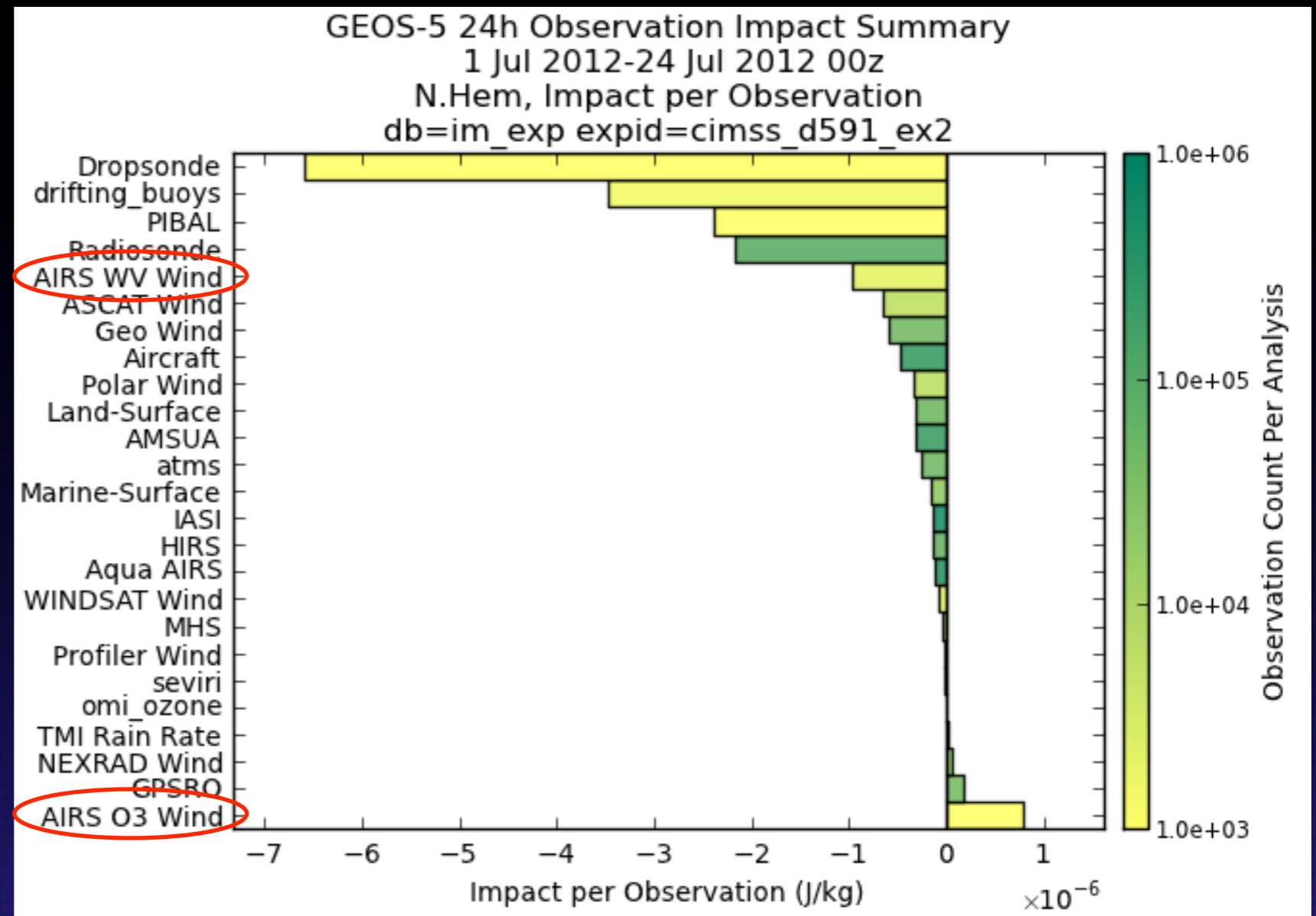
Forecast Experiments

- GEOS-5 Forecast System (reduced resolution)
 - GEOS-5 AGCM + GSI analysis ($\sim 1/2^\circ$ L72)
 - 3DVar
 - 6-h assimilation cycle
 - 7-day forecasts, adjoint-based 24h obs
 - Impacts at 00z (dry energy norm, sfc-150 hPa)
- Dates: 14 June – 31 July 2012
- Experiments
 1. Control
 2. + AIRS winds
 3. + AIRS winds - MODIS WV winds
 4. - AIRS winds - MODIS all winds

Impact per observation

AIRS retrieval **humidity**
AMVs have a significant
positive impact/observation

AIRS retrieval **ozone** AMVs
have a negative
impact/observation



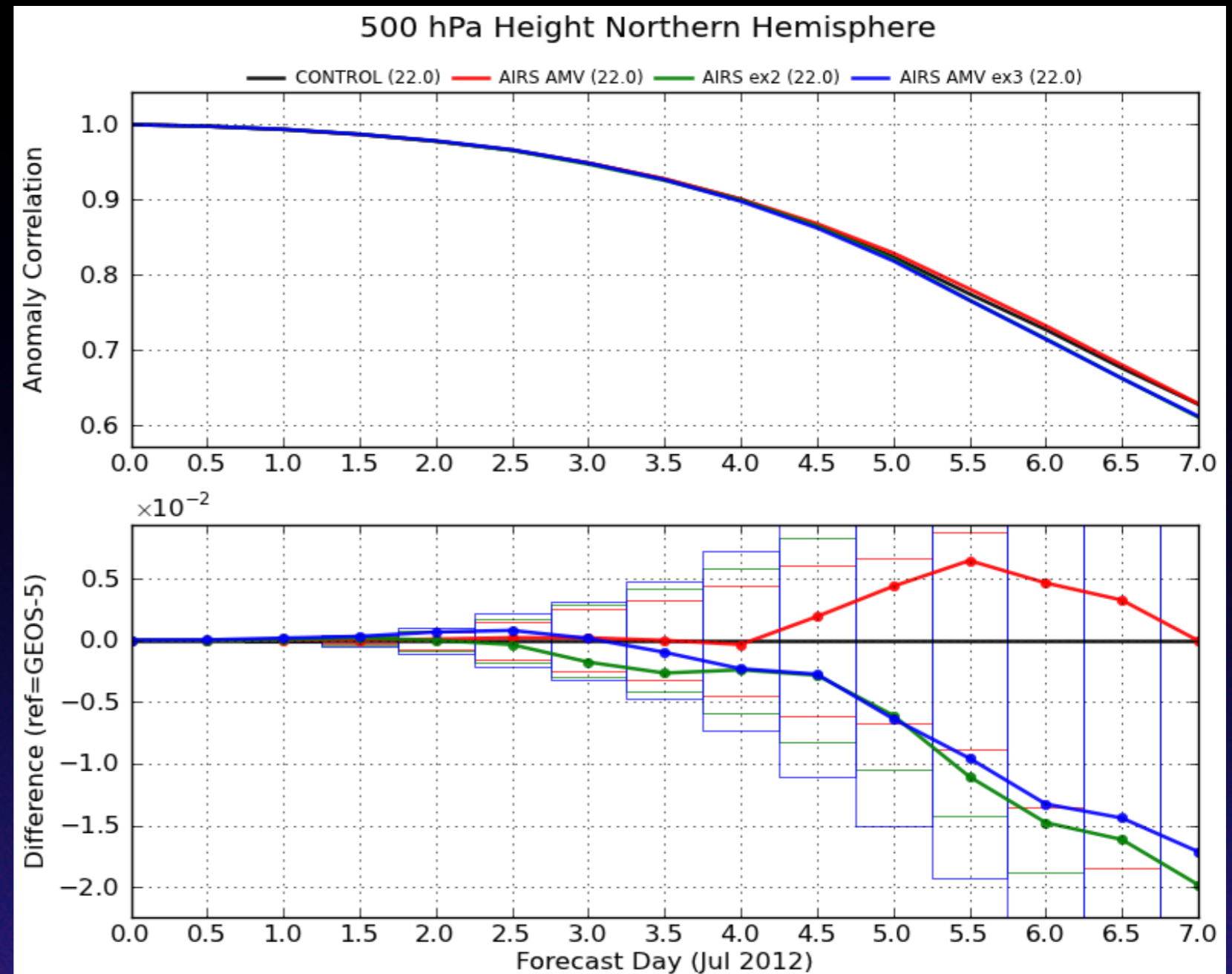
1 – 24 July 2012 00 UTC

Anomaly Correlation Coefficient

Red: Addition of AIRS AMVs shows a **slight improvement** in the ACC score after Day 4; not statistically significant.

Green: Removal of WV MODIS AMVs results in **decrease** in ACC. AIRS AMVs are unable to offset that loss.

Blue: Removal of all MODIS AMVs results in **decrease** in ACC. AIRS AMVs are unable to offset that loss.



500 hPa Northern Hemisphere
1 – 24 July 2012 00 UTC

Summary of AIRS AMVs



- The AIRS AMVs compare favorably to co-located MODIS AMVs for a six-week period:
 - Zero speed bias; standard deviation of 3.5 ms^{-1}
- Only 8% of MODIS AMVs colocated with AIRS AMVs:
 - MODIS AMVs: Clouds and clear-sky water vapor features (single level)
 - AIRS AMVs: Clear-sky and above cloud top (3D)
 - AIRS AMVs complement MODIS AMVs

Summary of AIRS AMVs



- Impact per AIRS moisture AMV is ranked higher than all other satellite-derived wind datasets
- Neutral, or slightly positive, forecast impact due to the addition of the AIRS retrieval AMVs is encouraging:
 - AMVs are only in the polar region (poleward of 70° latitude)
 - Impact in the longer range forecast over the entire northern hemisphere ($20^\circ - 90^\circ$ latitude)

New Award: NASA ROSES 2013 A.28



Real-time Generation of Atmospheric Motion Vectors from AIRS Retrieval Data

Motivation

The WV channel (27) on Terra MODIS is degrading:

- Only 2 out of 10 detectors are good
- Loss of Terra MODIS clear-sky winds

Next-generation polar weather satellite era began with Suomi-NPP satellite:

- Two additional satellites will launch over the next decade (JPSS)
- VIIRS instrument (no water vapor channel)
- No clear-sky imager WV winds

New Award: NASA ROSES 2013 A.28



Real-time Generation of Atmospheric Motion Vectors from AIRS Retrieval Data

Goals

1. Automate procedures to generate AIRS AMVs in near realtime
2. Blend AIRS and Aqua MODIS AMVs
3. Collaborate with NWP partners for monitoring and assimilating the AMVs
4. Make product available by the end of 2014

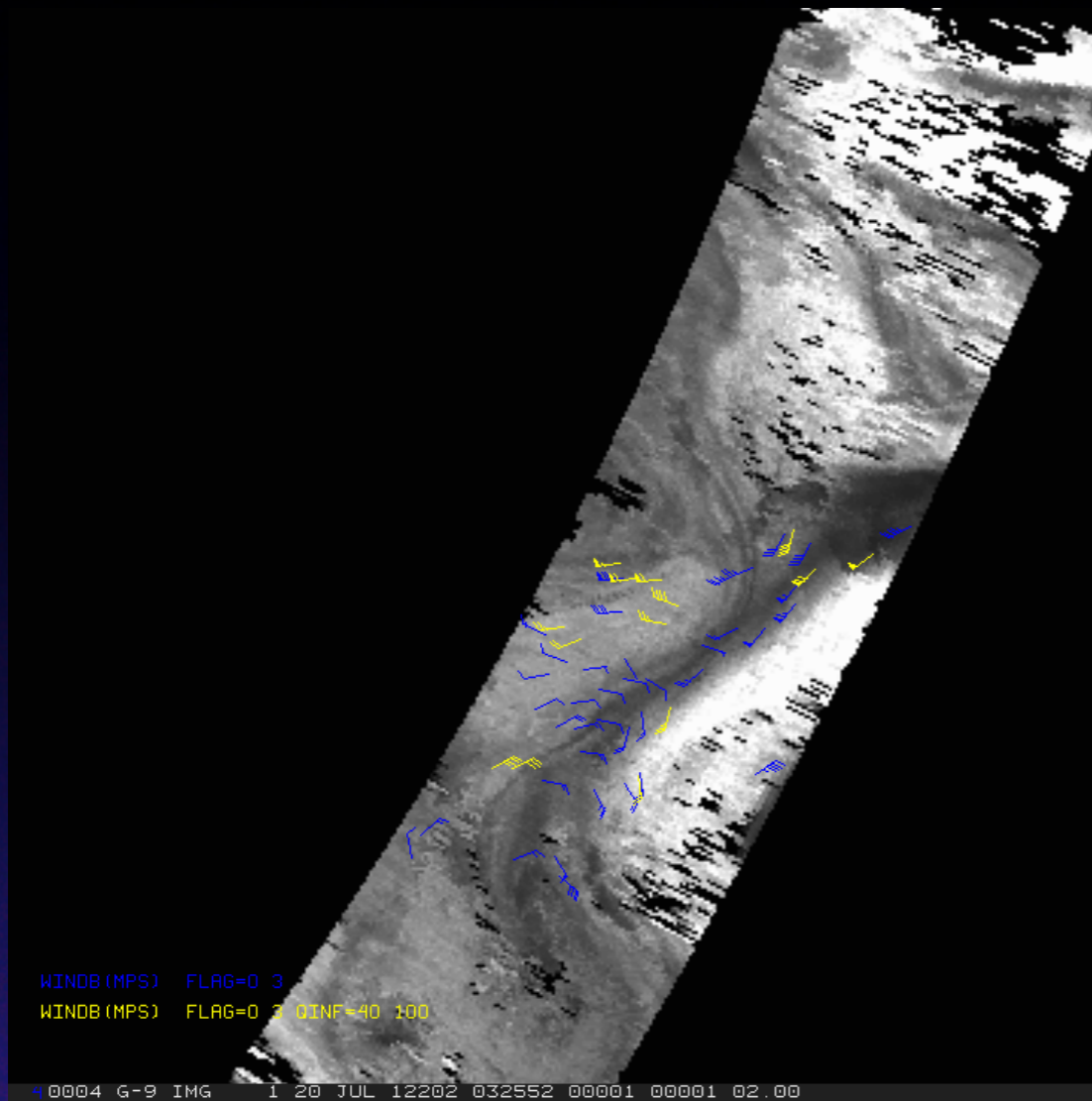


Future Application of Technique

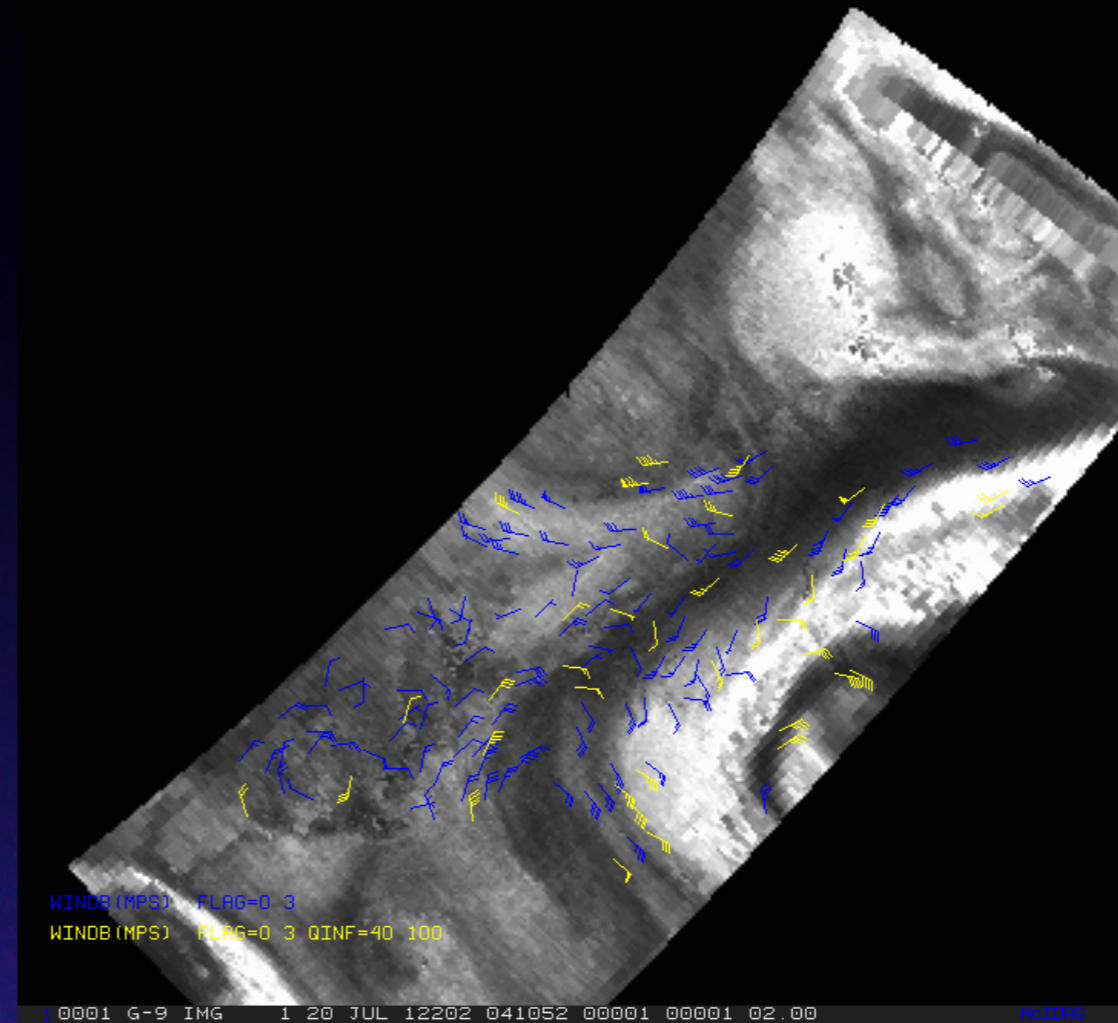
Technique can be applied to other satellites:

- **Polar imagery winds** are currently being generated from AVHRR (Metop-A and -B) and VIIRS (S-NPP)
- **SSEC SFOV retrieval algorithm** has been applied to **IASI** and **CrIS**
- Therefore, blended AMV products could be generated for:
 - **AVHRR/IASI** on Metop A- and B-
 - **VIIRS/CrIS** on S-NPP and JPSS
- Investigate cross-platform humidity feature tracking:
 - Shorter time interval between images
 - Coverage would extend further south
- And, perhaps other instruments.....

AIRS and ATMS Retrieval Images and AMVs at 400hPa



AIRS 20 July 2012 0505 UTC



ATMS 20 July 2012 0551 UTC

Specific humidity retrievals: **SSEC SFOV** for **AIRS**; **NOAA MiRS** for **ATMS**
All winds (blue); Quality controlled winds(yellow)



Thank You!

NASA Grants: NNX11AE97G and NNX14AI77G